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PATENT SPECIFICATION 938,381

DRAWINGS ATTACHED.

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COMPLETE SPECIFICATION.

Dehydrated Purees and Method and Apparatus for Preparation thereof.

We, GENERAL FOODS CORPORATION, a Corporation organized under the laws of the State of Delaware, United States of America, of 250 North Street, White Plains, State of New York, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to pureed food product and to a novel apparatus for producing dehydrated pureed food products suitable for feeding infants and adults requiring geriatrics or post-operative care; and which may be generally useful in the preparation of soups, desserts, and other food preparations. More particularly, the invention relates to the manufacture of dehydrated strained food products which have a relatively high percentage of natural or added sugars and/or pectinous substances; which are readily rehydratable in cold tap water, milk or other aqueous liquids; and which, when frozen in a relatively dehydrated condition, are free from agglomeration whereby a free-flowing readily handled product is obtained.

Puree, for the purposes of the present invention, is any food material which has a liquid or semi-liquid form containing solid particles, said food material being capable of being concentrated and formed into a film which is removed in a continuous and stretchable form from a drying surface.

In the art of preparing so-called dry-frozen fruits such as pears, peaches, apples, apricots, tomatoes, cranberries and the like, in the form of a puree, it is desirable that the product have the ability to rehydrate "instantly" and completely; in this connection the term "instantly" is used to describe a product capable of rehydrating in about 30 seconds and ranging anywhere from a period of a few seconds to one minute, which hydration can take place in cold, lukewarm, warm or boiling water or other aqueous liquid and is accompanied by a rapid increase in viscosity.

Heretofore, in recognition of the economies offered in terms of reduced package weight and volume, proposals have been made for processes to reduce the moisture content of fruits by dry-freezing them. Most dehydro-freezing practices involve a relatively slow drying operation, during which operation, certain factors are operative to impair the desired rehydration characteristics of the product. Typical of such slow dehydration procedures are processes employing so-called tunnel or truck dehydrators which have been used for many years to dehydrate vegetables and fruits. For the drying of fruit purees, more rapid and economical drying may be effected by passing a slurry of puree onto a revolving drum, the outer surface of which is heated and which offers a drying interface having good heat transfer and particle release properties capable of increasing the solids content of the puree from say 9—30% up to 98—90% solids but preferably not above that solids level where flavor, color, and nutritive content suffer.

Throughout this Specification, all percentages are percentages by weight.

In carrying out such a drum drying operation, a number of difficulties are encountered which tend to impair the rehydration characteristics of the dried product. The partially dehydrated film of product is plastic at the point of removal from the drum and when removal is effected by a doctor blade tangentially engaging the smooth surface of the drum there may be a build-up of product on the doctor blades such that as the product is removed from the drum, it assumes a wavy irregular surface of somewhat crepe-like appearance due to the deceleration of the film as it leaves the dryer. Build-up of this thickness of product is adverse to rapid rehydration of the doctored product.

Heretofore prior art drum drying practices have been concerned with the problems involved in protecting the product doctored from a drum dryer against overheating. Thus, in conventional prior art techniques it has been suggested that a blast of cold air be directed at the doctoring or scraping point or that the continuous film of product doctored from the drying surface be rapidly removed from the vicinity of the drying surface. However, such prior art practices fail to endow the continuous film thus dehydrated with any substantial rehydration or reconstitution properties. Such prior art is only concerned with maintaining a substantially continuous unbroken web or film consistent with good uninterrupted manufacturing practice such that a minimum of time loss will arise from film breakage.

It is also a feature of prior art drum drying systems, which are intended to be used to dry films of, e.g., foods, that the continuous film traverses a great distance typically greater than three feet and usually 3—4 feet from the point of removal (i.e., the doctoring point) to the point at which it first touches any subsequent conveying rolls. When the film, as withdrawn from the drum, is quite hot, prior art pieces of apparatus have attempted to cool it as quickly as possible and this has been done by providing a greater distance between the doctor point and the point of first contact with subsequent conveying rolls.

In accordance with the present invention an improvement in the art of drying a puree, puddings, and similar products having a relatively high proportion of natural or added sugars and/or pectinous substances initially present, added or liberated in cooking is achieved in a manner which meets the foregoing need for an instantly rehydratable product in film or flaked form; for each of reference the products processed in accordance with this invention will be referred to hereinafter as "purees", but will be understood to encompass soup stocks, slurries and solutions containing solid particles, all of which compositions tend to form continuous stretchable films rather than a powder upon removal in a concentrated form from a drying surface. The improvement comprises applying a puree having finely divided food solids at a level usually of 9—30% (but sometimes higher) to a smooth surface whereon the puree is heated, concentrated and converted into a continuous film having a syrupy viscous elastic condition while in the heated state; in this condition the finely divided food solids are suspended in a plastic liquefied sugar and/or pectin-like saccharaiferous plastic carrier which supplies to the film a tensile strength varying from product-to-product, but in any event sufficient to permit the product to retain a continuous cohesive nature after it is stripped from the heating surface and while it is stretched to the evtent specified herein. Stripping is preferably facilitated by such means as a doctor blade. Usually, the moisture content of the stripped film will be less than 12% and higher than 2% by weight of the film. The film is continuously stripped in its molten condition.

In accordance with certain aspects of this invention, the apparatus for producing a dry stretched film may comprise a drying surface on which a continuous film of material may be deposited; means for depositing said film of material on said drying surface; means for heating said drying surface whereby the deposited film thereon may be heated and dried to a stretchable state; means for removing said film from said surface as a continuous film; a stretch roll for subjecting said removed continuous film to tension substantially in excess of that required to prevent agglomeration during removal, sufficiently great to stretch the film, sufficiently great to impart a random distribution of discontinuous surface failures and void spaces throughout the film, and less than the failing tension of the film; and an interrupted rider wheel adapted to bear against said film of material as the material passes over said stretch roll, thereby positively maintaining said tension during said removal and effecting stretching of said film while it is in stretchable condition.

It is a particular advantageous feature of the process and apparatus of this invention that it permits subjecting the sheet of film to tension over a short distance which extends between the doctor point and the first contact with the stretch roll. This distance is as short as possible, preferably less than 3 ft. and typically 1 to 1.5 ft., although the distance will vary as the relative consistency of the product being stretched varies in the atmospheric conditions at the time of drying.

It has long been appreciated that the various techniques and prior art pieces of ap-

paratus which have been employed are deficient in that they fail to permit attainment of a product which is readily rehydratable. Various modifications of the apparatus have been made, and much thought has been given to the design of apparatus by those skilled-in-the-art, but no apparatus has heretofore been devised which permits attainment of the desired product possessing the superior characteristics hereinbefore noted.

In the preferred embodiment of the invention of that application, the apparatus may include a double drum dryer, a stretch roll for stretching sheets of the material withdrawn from the dryer, and a riding or hold-down wheel which facilitates the development of the tension in the film and thus assists in the necessary stretching of that film.

In the use of such a novel combination of apparatus, it was noted that the rider wheel would preferably be either a single cylindrical roll, although a series of spaced shorter rolls was satisfactory. In many, and perhaps even in most cases, either structure will function very satisfactorily. In the case of certain very sticky foods, however, it is found that the film passing between the take-away or stretch roll and the riding, tension, or idler wheel will adhere to the latter wheel and thus disrupt the operation of the machine. This effect is particularly noted in the case of foods typified by the following: peaches, pears, and tomatoes.

The tension should be sufficient to stretch and thereby elongate the film whereby food solids are thinly and discretely dispersed in the still molten saccharifierous carrier therefor and whereby fibrous and other insoluble food solids contained in the film appear randomly arranged and unoriented to the unaided eye. Films of peach and pear purees, and to a lesser degree apple and tomato purees, will have greater tensile strength than pudding films due to the higher proportion of pectinous materials in the fruits. Consequently, such fruit purees will generally call for a higher amount of applied tension than puddings; in this connection, the temperature of the stripped film will contribute to its stretchability and although a rapid cooling of the film being stretched is desired it should be sufficiently molten, at least in the initial stages of elongation, to create the stretched condition herein specified; however, the product temperature generally will not exceed 212° F. while it is being stretched. Usually, this stretched condtioin will be evidenced by a random distribution of discontinuous openings, surface failures and void spaces throughout the stretched film and will also be evidenced in many natural fruit purees by minute blisters or puffs barely visible to the unaided eye, giving rise in many cases to a plurality of postules some of which are broken and some of which are substantially intact.

Under a high powered microscope the stretched cooled product can be seen to comprise a translucent base layer or phase which is continuous and holds dispersed solids or agglomerates with the surface of the product also being translucent, the aforesaid discontinuous openings, surface failures, and void spaces in the product occurring in the continuous phase indicating a loss of elasticity at spaced points of the saccharifierous carrier for the food solids.

The thickness of the film of product after stretching will vary from product-to-product in accordance with the stretchability of the product and the degree of stretching required to render it instantly rehydratable. Usually the stripped film will be reduced to a thickness less than 0.050 inch and ranging anywhere from 0.005 inch upward.

Hence, the tension employed in accordance with the present invention for removal of the film from the heating surface is well in excess of that normally required to prevent agglomeration of the product and rapid removal of the film from the drying surface, but below that tension at which the film will fail completely, which failure would be evidenced by a complete film fracture resulting in interruption of the continuity of the film.

Stretching can be carried out by any positive controllable means for accelerating the rate of travel of the stripped film relative to the rate of travel of film at the point of stripping. Because of the desired film characteristic such stretching means should be capable of creating such a rate increase uniformly without inducing excessive tension while assuring the creation of sufficient tension to establish and maintain a high degree of dispersion of food solids throughout the molten carrier therefor.

By virtue of the condition of the film created by stretching, there is an ideal distribution of the water soluble and water insoluble food solids therein with the film displaying attractive colors and offering fresh flavors upon reconstitution. Most of the water soluble food solids appear to be in the continuous phase, with most of the water insoluble solids being thinly and discretely dispersed therein as a discontinuous phase. A substantial majority of the surface of this thin film is also comprised of said continuous phase. By virtue of this arrangement, and condition of water soluble and water insoluble food solids, though the water soluble solids will go into solution quickly in cold water, this does not occur at the expense of the water insoluble solids which are ideally dispersed and have the greatest opportunity to rehydrate without clumping.

Flakes produced by breaking the film will

have been broken into various sizes depending upon the rehydration characteristics of the particular puree being dried. For most fruit purees and puddings, the film will preferably be flaked into a particle size whereat 100% of the product passes a 10 mesh U.S. Sieve series screen (0.030" wire), although even larger size flakes may be produced with acceptable rehydration properties. In general, the film without further treatment according to our process, should not be broken up to a very fine particle size, viz., below a 40 mesh U.S. Sieve series screen (0.010" wire), since in breaking up the film the particles tend to lump during handling or storage into a candy-like ball which will not hydrate instantly in cold water.

The importance of the foregoing stretching will be appreciated when it is considered that in the case of a plastic and yet stretchable film of puree which is not stretched to the extent and in the manner contemplated herein and from which product heat is allowed to dissipate, a flaked puree will have relatively poor rehydration characteristics; e.g., 3—10 minues will be required, when the product is reconstituted in cold or lukewarm water 40°—80° F.) before the desired smooth, even texture and viscosity is obtained. In the case of the aforesaid stretched film and the flake product of the present invention, the puree product has rehydration characteristics which can be appropriately termed "instantaneous" and which broadly speaking has the ability to reconsistute to the desired viscosity in cold to lukewarm water (40—80° F.) in less than 60 seconds depending upon the product, usually 1—30 seconds. Apple purees are the fastest in rehydration, this phenomenal rehydration being manifest in the form of a "blossoming" of the product upon reconstitution in water. In the case of pears a slight delay in the order of say 5 seconds is observed before such blossoming occurs. In any event, the foregoing rehydration characteristics prevail in a wide variety of fruits, and the term "fruit" as it is employed in the accompanying claims is intended to cover any plant having a high natural sugar content, say in the order of 13% by weight of solids, and represented by such common fruits as apples, cranberries, peaches, pears, apricots and the like.

The term "stretchable" as it is employed in the foregoing statement and in the accompanying claims is intended to describe that plastic condition which prevails when the puree has been reduced to a content generally in the range of more than 88% solids and less than 98% solids, the upper range of moisture content being limited by the characteristics of the plastic state as well as the characteristics of the product itself which at an unduly high solids content can be deteriorated by excessive heat treatment; in general, it has been observed that moisture between 2—10% in the stretchable mass is desirable but still higher moisture content in the order of 15% can also be practiced while carrying out the present invention; for natural fruit purees not having additives therein a moisture content in excess of 10% will be characterized as soupy; however, modifying thickening agents such as starches, gums, dextrines and the like, detailed hereinafter and capable of increasing the tensile strength of the puree, will of course alter the moisture content at which this desired stretchability will be found to prevail.

A very good rule to observe in determining the degree of stretching which should be practiced is that the product should be stretched to the extent that a plurality of minute surface ruptures appear on the film surface.

Stretching is achieved preferably by causing the film of product to travel in a substantially uncompressed fashion over take-up means operating to cause the film of material to travel at a rate greater than that at which it is removed from the heated film-forming surface.

To effect proper film flaking, control of product moisture and/or temperature is essential, depending to a great extent on the nature of the material being treated. The product should be in a friable, crisp condition and should remain in this condition after flaking to preserve its free-flowing "instantly" rehydratable character. This friable condition is induced and maintained by subjecting the stretched concentrated curtain of product to controlled atmospheric temperatures and humidities.

Products passing from the stretching means under varying operating conditions may or may not have been cooled to a temperature and adjusted to a moisture content whereat the curtain of solids can be readily flaked under normal atmospheric conditions to yield instantly rehydratable material. Under conditions of high relative humidity certain products, typically many of the fruit purees mentioned above and puddings, will absorb atmospheric moisture due to their hygroscopic character. Other products such as apple sauce and tomato paste, even under ideal atmospheric conditions, i.e., low wet pulb temperatures, will require further downward adjustment of product moisture content. Even when a curtain of product has been dehydrated to a point where it will flake properly, i.e., will not ball-up in handling by a conveyor, there will be situations calling for reduction of temperatures also, even though substantial temperature reduction takes place in the course of stretching the product.

To illustrate, apple sauce puree will be tripped from the dryer at 7% moisture and in a stretched cool condition at 5% moisture can be flaked. Nevertheless, under atmospheric conditions of high relative humidity and temperature, the same product removed from a drying roll at a much lower moisture than 7% and having when stretched an even lower moisture content than 5% will not flake effectively and retain its free-flowing and rehydratable properties after storage unless the curtain of product is subjected to a dehumidified air and preferably refrigerated dehumidified air. Dehumidification and chilling will for the most part be called for at relative humidities above about 60% and temperature above 80° F.

Broadly, the film of product to be stretched will have a moisture content ranging between 2—7% before stretching (generally about 4.5%) and a moisture content ranging between 5—3% after stretching (generally below 4.5%). It is preferred where products contain a high percentage of sugars, starches and acids to chill the curtain of product by use of recirculated cooled air at a temperature below 70° F. and at a relative humidity below 45%, although as noted above some acceptable products can be obtained when employing slightly higher relative humidities and air temperatures. When the products being processed are fruit purees and puddings, unchilled flakes thereof stored in a room having an air temperature of 7° F. to 10° F. tend to become lumpy and unworkable in a span of about 24 hours. Thus, it is a very distinct advantage and necessary for most fruit purees to employ conditions under which the product has a temperature well below 70° F. as it is introduced to a flaker as it leaves the flaker since the resulting flaked product will be free-flowing and perfectly workable after being stored in bulk and later packaged as the need arises. In accordance with the most preferred chill flaking concept, ordinary refrigeration means using recirculated dehumidified air as less than 30° F. dehumidifies as well as cools the curtain of stretched product to the desired extent prior to flaking. On the other hand, other means may be employed to effect such treatment continuously during flaking and a preferred modification of apparatus to be described hereinafter is a screw conveyor which is enclosed but for a port of entry to the screw, a source of recirculated dehumidified cool air being introduced to the enclosed conveyor counter-current to the movement of product; in such conveyor means the curtain of product will be somewhat broken but the flaking operation will occur when the product is delivered to a flaker which is also enclosed and is located downstream from the conveyor. The flaker may comprise any suitable well-known flaking apparatus capable of breaking a sheet of product and passin through a screen; such a flaker usually employs a series of driven paddles which force the proluct through a screen of a U.S. Sieve series size generally below 40 mesh.

Thereafter the product can be stored in a suitable refrigerated atmosphere or packed directly either in an inert gaseous atmosphere or under normal atmospheric pack. Thus, the product may be packaged in sterile air-tight containers such as tin cans in an inert gaseous atmosphere, e.g., nitrogen. However, a far less expensive packaging system which is ideally and peculiarly suited to the stretched flaked purees of the present invention is the packaging and sale of these products in a frozen condition (0° F.) in any conventional frozen food package.

Having described the product and process features of the invention in general terms, it will now be more fully developed by description and photomicrographs of various chill flaked samples and of apparatus for carrying out the invention.

Figs. Ai, Aii, and Aiii are photomicrographs of apple-apricot purees which have been unstretched, stretched to a medium extent and stretched to a maximum extent after drying, respectively;

Figs. Bi, Bii and Biii, Figs. Ci, Cii and Ciii, and Figs. Di, Dii and Diii are corresponding photomicrographs of other purees, viz., pear, apple sauce and vanilla puddings, respectively. Thus, photomicrographs designated by (i) represent unstretched dehydrated product and photomicrograhs (ii) and (iii) represent the medium stretched and maximum stretched dehydrated purees of the present invention.

Fig. 1 is a schematic elevation showing apparatus whereby the puree is stretched and the curtain of product is conveyed away and flaked;

Fig. 2 is a top plan view of the apparatus in Fig. 1;

Fig. 3 is a side elevation view of the apparatus in Fig. 1;

Fig. 4 is a schematic plan view of conveying and flaking means showing means for recirculating dehumidified refrigerated air counter-current to the flow of stretched product to the flaker; and

Fig. 5 is an enlarged elevation with parts cut away of film breaking means in Fig. 1.

Figs. Ai, Bi, Ci, and Di show control samples removed from doctor blades of a conventional atmospheric double drum dryer by means of a conventional take-away roll wherein the product is draped loosely over a take-away reel and whereon a curtain of the product is cooled as it is pulled by the friction existing between the product and the surface of the reel; these samples have a generally corrugated crepe-like gross appearance, and when viewed under a high-powered

microscope at greater than 200 diameters, are seen to comprise thick coalesced agglomerates on the surface of the crepe-like flake arranged in ridges having a generally unilaterally organized direction. The agglomerates are believed to be soluble solids from the cells of the puree in the case of the fruits, i.e., Figs. Ai, Bi and Ci. The supporting base structure for these ridges is seen to contain numerous fibres and fibrils, apparently derived from vascular plant fibres and cell walls. In the case of the vanilla pudding (Fig. Di) the base layer contains few starch granules having polarizing characteristics similar to those in a raw gelatinized starch; no cellular character or other distinguishing features could be noted.

Referring now to Figs. Aii, Bii, Cii and Dii, these are medium stretched samples of apple-apricot, pear, apple sauce, and vanilla pudding purees which have been stretched or elongated in the manner aforesaid and by apparatus hereinafter described. These "medium stretch" samples all show distinct thinning of the sample. When viewed under a high-powered microscope surface agglomerates are spread apart in distinct clumps setting on a base layer which is translucent and in the case of fruit purees contains numerous fibres and fibrils apparently from plant vascular remnants and cell walls; these fibres and cell remains indicate the effects of severe distortion and rupturing due to mechanical treatment. As seen in the photomicrographs, the base layer begins to show signs of tearing and some open areas indicate that rendering action has taken place; the increases in surface areas between the product series of (i) and the medium stretch samples of series (ii) are quite great and highly significant in the provision of instantly rehydratable purees. Referring to the photomicrophragh in series (iii) the maximum stretch samples of puree show in a more pronounced manner the effects found in the medium stretch samples, it being understood that the more preferred stretched puree of the present invention is the maximum stretch product, although for some products, depending upon the raw material and composition of the overall puree, a medium stretch sample will be acceptable, e.g., apple sauce as distinguished from pears and peaches will call for a higher degree of stretching of the type portrayed in series (iii). Again, when viewed under a high-powered microscope the base layer or continuous phase is translucent and the cellular remnants appear to be broken and ruptured to a greater extent. As seen in Figs. Aiii, Biii and Ciii, tears and breaks are great in number and extent. Under a high-powered microscope the agglomerates on the surface of the product appear to be spread further apart and are generally smaller in the case of series (iii) than in the case of series (ii).

The above description of the products of series (ii) and (iii) reveals evidence of a tremendous pulling, shearing and tearing action on the substrate with resulting dislodgment of cellular contents to the surface of the supporting base layer, composed in the case of fruits of cellular remnants. Although more basic biochemical and biophysical forces have probably been active during the present stretching process which may have contributed to the greater rehydratability of the products of series (ii) and (iii) over the products of series (i), the physical changes noted account at least in part for the improvements in rehydratability obtained, the tremendous increase in surface area and reduction in sheet thickness as well as the displacement into a dispersed discontinuous phase of agglomerates of food solids in a matrix of amorphous carbohydrates and other constituents also contributing to an ideally rehydratable structure. Although these agglomerates of food solids may be generally designated as "soluble", these products are more commonly referred to as rehydratable and suspendible materials. Generally the continuous phase will be found to comprise in the majority sugars or carbohydrates in a solid amorphous form as a consequence of the rapid cooling which takes place upon stretching.

The composition of this continuous phase, of course, depends upon the raw materials from which the puree is made. Thus the puree may be compounded from comminuted fruit solids and fruit juices and mixtures thereof which it is possible to combine with vegetable solids and juices, meat solids, and comminuted vegetable-meat mixtures if desired, most of which in a concentrated condition lend themselves to the stretching technique of the present process.

However, as illustrated by the composition of Figs. Di, Dii and Diii, the puree may be composed of other comestibles such as puddings high in starch and sugar levels and possessing a tacky, stretchable, viscous nature; in this latter category of materials, various flavored puddings, such as vanilla, chocolate, orange and the like will be most suitable, the starch of such compositions being potato, arrowroot, sago, corn, etc., either gelatinized or partially gelatinized. Overall, a substantial fraction of the non-aqueous constituents of the pudding puree will be starchy in nature or origin and will have been gelatinized to a gel-like consistency by reason of the heat treatment the puree undergoes as its solids content is increased on the drum to render the puree film-forming and stretchable.

Typical of those useable thickening

materials or "modifiers" which are starchy in nature, but not in origin as the term is commonly understood and which may be employed to render the concentrated puree stretchable are polysaccharides and cellulosic ethers, such as pectin, algin, Irish moss extract, gum arabic, gum acacia, alkali metal salts of carboxymethyl cellulose (CMC) and other non-ionic ethers of cellulose, the ionic ethers of cellulose, such as ethyl cellulose, methyl cellulose, methyl ethyl cellulose, hydroxy propyl methyl cellulose and hydroxy ethyl cellulose. The present process contemplates that puree compositions can also be obtained by blending one or more of the foregoing gelatinous polysaccharides with proteinaceous materials of animal or vegetable origin, preferably isolated in a gellable heat denaturable condition; e.g., alkali or ethanol extracted soy protein, peanut protein, fish protein and the like.

The greatest utility for the products of the present invention is in goods intended for infant and geriatric feeding where the facility of use and the desirable appearance and flavor as well as the likeness to fresh fruit are pleasing to the palate. Included in the term "fruit" are tomatoes, pears, apples, apricots, peaches, prunes and cranberries; mixtures of such fruits will also be found useful and pleasing in taste, e.g., apple-apricot, pear-apple, etc.

Products acceptable as junior foods or soups may also be produced in accordance with the present invention. Thus concentrated soups of tomato, asparagus, pea and the like may be produced from the cooked pureed vegetable. Many of these vegetables will not have an inherent elastic nature such that they would not ordinarily have the stretchable character herein described. However, many of these materials do contain natural pectinous or pectin-like materials, e.g., cooked tomato paste, which are sufficiently elastic in a concentrated pureed form to be stretched as a film into products having the foregoing characteristics; for those materials which do not possess sufficient inherent elasticity modifiers may be added to the puree prior to its concentration to a viscous state, such that films thereof may be stretched; for example, pectin or algin when added to a pea puree will lend sufficient stretchability to a sheet of product stripped from a drying roll.

Typical of other materials which may be similarly processed are those containing a substantial proportion of fat associated either with meat or dairy products such as milk or butter. In such mixtures of starch, vegetables, fruits, and/or meat solids with such fatty constituents will offer a tacky, elastic quality to a concentrate doctored from a suitable drying surface and the concentrate can be elongated to a film of reduced thickness and will cool rapidly. The product resulting from such stretching, for example, a puree composed of carrots, bacon, celery and rice flour will be found to be stretchable under the conditions herein specified and will be found to be instantly reconstitutable.

Purees of the foregoing types will best be concentrated by employing drying equipment which concentrates the product to a solids content whereat the concentrate will adhere to a drying surface having a suitable release property wherefrom a film of concentrate can be doctored and continuously stretched by manual or mechanical means. Typically one or two chrome-coated atmospheric drum dryers associated with doctor blades engaging the concentrate will be used in combination with suitable means for uniformly stretching the film or curtain of product in a controllable manner. Of course, the stretching means are a very important feature of the present process. The design and location thereof will be dependent to some extent upon the type of drying apparatus employed to produce the film processed therethrough. The stretching means should be capable of continuously applying tension to the product issuing or removed from the drying area and should also transfer the product in the form of a thin curtain of film suitable for subsequent handling, which handling will usually involve dehumidification of the stretched film preferably by means of refrigerated air. Preferably the stretching means should only serve to accelerate travel of the film with respect to a portion thereof. In effecting such acceleration and stretching it is desirable to avoid a highly calendered densified condition in the product. Ideally, such stretching means comprise a stretching roll having a frictional surface above which is mounted idler means. Thus, the degree of stretching required calls for means for insuring sheet travel commensurate with the peripheral speed of a tension roll or reel, such action being insured by a positive contact against the take-away roll or reel as provided by idler rolls or wheels of such size, number and placement to provide a gentle gripping contact. While such idler means are preferred, other means will doubtless occur to those skilled in the art and indeed the hands of the operator skillfully placed have been found to provide the same stretching effect but, of course, with less continuity of tension. The take-away roll may be suitably equipped to apply suction to the contacting face of the sheet passing thereover thus again insuring a positive travel of product in accordance with the peripheral speed of the roll or reel and incidentally withdrawing both heat and moisture; such a modification would comprise a roll having a plurality of perforations communicating with a vacuum so as to provide means whereby suction is applied at the peri-

phery of the roll only at the arc of contact required to effect the desired tension.

EXAMPLE I.

Referring to Figs. 1—4, a preferred embodiment of the invention employs a pair of oppositely rotating 24″ diameter chrome coated drums 20 and 22, operating at 1.5 r.p.m. and heated internally with steam at 20 p.s.i.g., each drum having 25 sq. ft. of drying surface, the means for doctoring, stretching and flaking being generally shown at 24, 26, and 28, respectively. Such doctoring, stretching and flaking means are shown associated with only one drum, i.e., 22, similar means employed for drum 20 not being shown. As seen in Fig. 3, a puree is delivered by any suitable means known in the art of drum drying, e.g., a pendulum feed to the pinch between drums 20 and 22 where the product is concentrated approximately 35% by weight until it has a solids content above 85%. In general the thickness of the sheet dried as the product passes the pinch between the drum and the periphery thereof will be dependent upon the gap or spacing between the drums, the drum speed, the nature of the puree and the steam pressure in the drums. The operation and adjustment of the apparatus will be described with reference to apple sauce which is prepared by cooking, cooling and straining to provide a puree having a solids concentration in the neighborhood of 17% by weight and fed to the pinch at 80° F.; the drum spacing for apple sauce is from 0.006—0.15″, preferably 0.010″. As the drums rotate, a portion of the liquid passes through the pinch between the drums and forms on the drums a thin film of the order of 0.01″ in thickness. This film is carried around on the drying surface of the drum during which time it is dried by the heat originating inside the drum. Typically the moisture content may be lowered from the charge moisture of about 65% to a dry moisture content of about 15%. The stretchable puree concentrate is produced at a rate of 0.62 lb. per sq. ft. of drying surface per hour and is doctored at 24 and passed over a 6″ diameter foraminous stretcher roll 30 formed of woven wire or expanded metal.

The circumferential speed of the stretch roll is sufficient to provide the hereinbefore noted tension in the film. Although it may be possible to mechanically interlink the stretching roll with the rotating drum dryer, and even to permit the two to rotate at the same r.p.m., it is preferred to drive the stretch roll independently. The stretch roll may be larger or smaller than the drum dryer rolls, but in anw case will rotate at an approximate speed to insure that its circumferential velocity is sufficiently great to impart to the film the degree of stretch herein noted.

In the preferred embodiment, the stretcher roll will possess a frictional or roughened surface which creates friction when the stretchable film passes thereover. The roughened surface may be foraminous or reticular, but in the preferred embodiment, the surface of the stretcher roll will include sections of expanded metal laths wrapped around a supporting means which may be foraminous, if desired. This lathing will preferably be so positioned that if the roll rotates, the surface edges of the lathing will be pointed in the direction of rotation, thereby providing a firm and positive tensioning action on the film placed in contact with the surface of the stretcher roll. It is also contemplated that the stretcher roll be suitably equipped to apply suction to the contacting face of the film or sheet passing thereover and incidentally withdrawing both heat and moisture. Such a modification may comprise a roll having a plurality of perforations contacting with a central vacuum means whereby suction is applied at the periphery of the roll at the arc of contact of the film with the stretcher roll.

The sheet of product is maintained in contact with the stretcher roll by a plurality of hard rubber rider wheels 32 engaging roll 30 at the point indicated and pivotally mounted on the frame of the machine to grip the curtain of product and cause it to travel with the stretcher roll substantially at the peripheral speed thereof; in this case the roll was driven at about 3.5 r.p.m. and the curtain of product produced was stretched to the extent shown in Fig. Ciii, the product having been stretched from a thickness at the doctor blade of 0.040—0.050″ to 0.015—0.020″ thickness.

It is a distinct feature of this invention that in the preferred embodiment, the apparatus includes an interrupted rider or tension wheel which will preferably consist of a wheel having a plurality of faces in the nature of either a single cylindrical wheel or a roll with portions of the face gouged out, or it may be a plurality of independently non-connected spaced wheels. In the preferred embodiment, the rider wheels are located on a single line of contact, the total length of the faces of the rider wheels which touch the line of contact on the stretcher roll being from 10 to 50% of the length of the line. The spacing of such wheels will be such that they fall within a small angle preferably not more than 30° as measured clockwise, relative to a vertical plane passing through the stretcher roll. Regardless of whether the rider or tension wheel be a single cylinder with an interrupted surface or a plurality of separate wheels, the spacing of the portions which contact the travelling sheet of film must be such as to extend a uniform stretching of the sheet without any

localized bunching of material and to impart a uniform tension thereto. It has been found that the preferred length of each of these rider wheels should be 1 to 4 inches. If they exceed this length, the film may adhere to the wheels and if they are less than this length, there is a tendency for them to cut the film and said operation would require an inordinate number to satisfactorily tension the sheet. The facing of these wheels is preferably of resilient material such as hard rubber or neoprene which provides the necessary yieldability and sufficient coefficient of friction.

The curtain of product falls into refrigerated conveyor and flaker means 28. Means 28 comprises an upwardly inclined screw conveyor 34 mounted for rotation within insulated tube 36 and driven by suitable variable speed motor through gear 38 by means not shown. The curtain of stretched product is deposited into tube 36 through a port 40 of a size suitable to receive the curtain of product. Mounted above port 40 is a hopper and breaker assembly 42. Referring to Fig. 5 this hopper and breaker assembly comprises a hood having elongated slot 46 therein adapted to receive a curtain of product therethrough, guide springs or wires 48 mounted to a stationary supporting member 86 serving to introduce the sheet in a substantially planar condition to the action of a plurality of breaker arms or fingers 52 integrally mounted on shaft 54 driven and journalled for rotation.

Recirculated and dehumidified cold air is adapted to flow upwardly within the hood and thereby chill product passing through slot 46. The chilled product is broken by rotating arms 52 passing between guide springs or wires 48, bypassing ports 56 and 58 which are provided at the lateral extremities of the hood to permit escape of the cold air, which is under pressure, from the hood rather than through slot 46 which would otherwise cause difficulty in maintaining feed from the stretcher roll through the slot 46 to the guide wires.

Broken product passing through the breaker assembly passes entry port 40 into the path of the rotating flights of screw 34 and is delivered upwardly along the inclined tube 36; communicating with the extremities of tube 36 is a cold air inlet port 60 and a cold air outlet port 62 adapted to circulate cold air counter-current to the flow of product by means schematically shown in Fig. 4. Broken product conveyed past inlet port 60 cascades downwardly from the upper extremity of tube 36 into the path of rotating paddles 64 of flaker 67 driven by suitable means not shown through gear 66, the paddle 64 being within circumferential screen 68 inside hopper 69 which is complementary to the path of travel of the free edges of the paddle 64.

Referring to Fig. 4, the preferred refrigerated air system will be seen to comprise an air separator preferably of the cyclone type 70, a silica gel air dryer 72, a plurality of indirect heat exchange units of the refrigerated coil type 74, an electrical heating unit 76 and a fan 78 adapted to recirculate the refrigerated dehumidified air in a counter-current path to the material passing from the drum dryer to the flaker. The silica gel dryer is of conventional design and while silica gel is described as the absorbent material any one of a number of absorbent materials are contemplated within the scope of operation of such a dryer. The refrigeration units 74 chill the partially dehumidified air to temperatures below freezing in many instances and in so doing condense remaining moisture which has not been removed by the inorganic absorbent materials in the dryer. Following the removal of moisture in the refrigeration unit the substantially dehumidified air is made subject to reheating in the heater unit designated by 76 wherein by gradual heating and expansion of the volume of air the relative capacity of the air to absorb greater quantities of moisture is greatly increased. The thus dehumidified air which is now not only dry but also hydrophilic by virtue of its partal reheating is recirculated by means of the blower fan 78 through the system in counter-current contact with the particles of product.

EXAMPLE II.

In accordance with a specific example of a process employing the apparatus of the instant invention, a pear puree (to which had been added 3% by weight of tapioca starch) having a moisture content of 86—88% was fed to a pool of pear puree maintained at the pinch of a double drum dryer. Clearance between the drums was 0.007—0.008 inch. The rolls 20 and 22 of the dryer were 24 inches in diameter and each had an effective heating surface (chrome plate) of about 25 square feet.

Steam was added to the interior of the drums at 20 p.s.i.g. and the drums were rotated at 0.8 r.p.m. The puree formed a film on the drum and as the hot drum rotated, the film was dehydrated to 2.5%—5% moisture. After traversing about 225° of the drum surface, the film of material was removed from the drum by a doctor blade 24 which was positioned substantially tangentially to the surface of the drum. The removed film passed substantially horizontally over a short distance to the stretch roll. During its brief time of passage, it cooled only slightly and it was stretchable or plastic.

The doctored film was passed over a 6-

inch diameter stretch roll 30 having a foraminous surface formed of expanded metal. The stretch roll was rotated at 1.33 r.p.m. and the sheet of film of pear puree was stretched as its passed thereover. A rider wheel 32 gently and firmly pressed on the film as it passed over the stretch roll 30 and insured a position and uniform maintenance of the tension.

The product pear puree film had a sheet thickness of 0.005—0.007 inch (unit weight 6.55 g. per square foot) and was characterized by a discontinuously ruptured surface. The so-stretched film was passed downwardly into stretch roll hopper 42 containing breaker arms or fingers 52 integrally mounted on shaft 54 which broke up the film into smaller sized pieces which then passed into insulated tube 36 containing screw conveyor 34. Here the dried puree was contacted by dry air flowing downwardly through the screw conveyor as the pieces moved upwardly therethrough under the influence of the screw conveyor. Temperature of air into the conveyor was 17° F. and air temperature out of the conveyor was 27° F.

The material left the screw conveyor at its upper end and passed into the flaker which included rotating paddles 64 (driven by suitable means not shown) which may gently press the pear puree pieces through the holes in a screen to permit attainment of the product in the desired size.

The dehydrated pureed product obtained by use of the apparatus of the instant invention is particularly characterized by its substantially immediate—to 5 second—rehydration on contact with liquid to give a desirable puree.

EXAMPLE III.

In still another example, 50 pounds of tomato puree is brought into contact with the surface of oppositely rotating drums 20 and 22 so as to flow to the pinch between the drums which are operated at a drum steam pressure of 20 p.s.i. and a drum speed of 0.8 r.p.m. The tomato puree is evaporatively conectrated until it has a solids content above 85% preferably 90%. The thickness of the sheet dried on the surface of the dryer drums will be dependent upon the gap or spacing at the pinch between the drums where the puree slurry is deposited on the surface of the drums, the drum speed, the steam pressure in the drum and the nature of the particular puree being dried. In the case of tomato puree, the sheet thickness on the drum surface prior to stretching will range from 4.0—7.5 thousandths of an inch. After removal by the doctor blade and passage between the stretcher roll 30 and rider rolls 32, the sheet thickness of the particular product will be reduced to 2.5—3.4 thousandths of an inch and a moisture content of 4%. The spacing between the drums employed when treating tomato purees is preferably 10 thousandths of an inch but it may go as low as 7 thousandths of an inch and still obtain suitable product.

The partially dried tomato puree sheet is removed from the drum by doctoring passed over a 6 inch stretcher roll 30 of woven wire mesh construction and held down thereon by 4 inch diameter rider rolls 32. The speed of the stretcher roll is about 1.25 r.p.m. The sheet of partially moist product is maintained against the surface of the stretcher roll by eight spaced hard rubber rider rolls which engage the web of product to hold it down and thereby increase the tension thereon sufficient to partially rupture the sheet. It is observed that the sheet of product as it is removed from the drum by the doctor blade ruffles up and tends to assert a braking tendency on the system.

The stretched sheet of product is then passed through the chill flaking apparatus as described in the preceding examples. The thus chilled and flaked product produced by the above apparatus and method will have been dehydrated to a stable moisture content of 2% and will exhibit a free flowing character as well as a capacity for rapid rehydration with good flavor qualities.

The flaked and refrigerated product produced by the above apparatus will have been dehydrated to a stable moisture content in the neighborhood of 2% and will possess the fresh flavor and color of the fruit from which the puree was derived. By virtue of the novel stretching action employed the continuous film of concentrated product need not be dehydrated or subjected to temperatures whereat such flavor and color values will be lost in storage. The flaked product when stored at 0° F. will retain its instant rehydration characteristics for a long period of time despite the presence of a substantial proportion of sugars and the otherwise hygroscopic nature of the puree which would cause it to cake on storage. Thus, although for many products it will be desirable to dry blend powdered sugar with the flaked puree the product may also be compounded with high proportions of sugar, that is higher than the amount naturally present and ranging upwardly to the neighborhood of 30% by weight of the flake.

Although the instant rehydration advantage and the desired flavor and color values will be preserved for most products when they are stored under refrigerated conditions, many products will retain their instant rehydration character and will not suffer an undesirable loss of flavor and color on storage; typical of such a product is tomato puree which need not be stored under refrigeration but yet which will rehydrate rapidly, that is in less than 3 minutes and assume a final viscosity higher than would

ordinarily be achieved from tomato purees which are dehydrated by other processes to a stable moisture content. Hence, though the products of the present invention have the greatest utility in the manufacture of refrigerated puree goods, the applicability of the invention and the scope of the accompanying claims are not to be so restricted since other products such as tomato will be endowed with the property of instant rehydration and will store adequately under non-refrigerated conditions.

WHAT WE CLAIM IS:—

1. An instantly rehydratable dried puree, as herein defined, food product which is permeated by a plurality of minute ruptures created by stretching a film in the plastic state and comprising a random and discrete distribution of food solids in a continuous translucent phase of water-soluble solids.

2. A dried puree food product according to Claim 1, wherein said water-soluble solids include a sacchariferous material.

3. A dried puree food product according to Claim 1 or 2, wherein said dried puree is a dried fruit puree.

4. A dried puree food product according to Claim 1 or 2, wherein said dried puree is a dehydrated tomato puree.

5. A method for producing an instantly rehydratable dried puree food product which comprises concentrating a puree containing finely divided water-soluble and water-insoluble food solids to a stretchable condition to a moisture content not greater than 15% by weight, forming a film of said concentrated puree, wherein said water-insoluble food solids are suspended in a plastic carrier, and stretching said film under tension to an extent which, while producing minute surface ruptures therein, is sufficient to distribute water-insoluble food solids randomly, thinly and discretely as a discontinuous phase in a continuous phase of water-soluble solids without breaking the continuity of the film.

6. A method according to Claim 5, wherein said plastic carrier is a sacchariferour carrier.

7. A method according to Claim 5 or 6, wherein said puree contains a high percentage of water-soluble carbohydrates and water-insoluble food solids.

8. A method according to any one of Claims 5 to 7, wherein said film subsequent to its formation has a thickness less than 0.050 and more than 0.005 inch and is stretched under atmospheric conditions, and if desired, is then subjected to a drying atmosphere to further reduce its moisture content.

9. A method according to any one of Claims 5 to 8, wherein the film of material, subsequent to drying, is cooled to a friable condition.

10. A method according to Claims 5 to 9, which comprises concentrating puree fed to the pinch between a pair of oppositely rotating heated film-forming drums, the pinch between said drums ranging between 0.006 inch to 0.015 inch at its narrowest point, stripping the concentrated puree from said film-forming surface as a continuous film having a thickness of 0.040 inch to 0.050 inch while in a hot plastic condition, and stretching the stripped film to a thickness of 0.015 inch to 0.020 inch.

11. A method according to Claim 10, wherein the stretched film of puree is cooled to a temperature substantially below 70° F. and broken into flakes.

12. A method according to Claim 11, wherein the film is broken into flakes in the presence of dry air at a temperature less than 30° F.

13. Apparatus for carrying out the method as claimed in Claim 5, comprising in combination a revolving heated drum on which a film of puree material may be deposited, a doctor blade engaging the outer surface of said drum and which removes said film from the drum as a continuous film; a stretch roll for subjecting said removed continuous film to tension, and an interrupted rider wheel or a plurality of separate rider wheels adapted to bear against said film of material as it passes over said stretch roll.

14. Apparatus according to Claim 13, wherein said stretch roll is a cylinder mounted adjacent to and parallel to said revolving drum and having its periphery formed to provide a frictional surface, the upper portion of the periphery of said cylinder being in the same horizontal plane as said doctor blade, and being positively driven in relation to said revolving drum to stretch said film between said revolving drum and cylinder, the portion of said film between said revolving drum and said cylinder being maintained substantially horizontally.

15. Apparatus according to Claim 13, wherein said interrupted rider wheel has a plurality of faces.

16. Apparatus according to Claim 15, wherein said interrupted rider wheel comprises a cylindrical wheel with portions of its cylindrical surface cut out.

17. Apparatus according to Claim 16, wherein said interrupted rider wheel contacts said stretch roll along a single line of contact which line is parallel to the axis of said stretch roll.

18. Apparatus according to Claim 13, wherein said interrupted rider wheel comprises a plurality of separate wheels each having a length of 1—4 inches, the total length of all the said wheels being 10%—50% of the length of the line of contact between the stretch roll and the rider wheels.

19. Apparatus according to Claim 13,

wherein said stretch roll is provided with a surface of expanded metal lath positioned with its sharp edges pointed in the direction of rotation of the stretch roll thereby assisting in subjecting said removed continuous film to tension.

20. Apparatus according to any one of Claims 13 to 19, comprising additionally a substantially horizontal conduit having an inlet at one end to receive said stretched film material from said stretch roll and an outlet at the other end, a screw conveyor within said conduit to convey said stretched film material from said inlet end of said conduit to said outlet end of said conduit whilst breaking it into flakes, an inlet for admitting air which has been refrigerated and dehumidified and then partially reheated to one end of said conduit, an outlet for withdrawing air from the other end of said conduit, said air in passing through said conduit contacting said material therein, and a material receiver for collecting said material at the outlet of said contact.

21. Apparatus according to Claim 20, which comprises an air dryer.

22. Apparatus according to Claim 20, which comprises an air refrigerator.

23. Apparatus according to Claim 20, wherein said conduit is inclined and said screw conveyor within said conduit occupies less than the complete cross-sectional area thereof.

24. Apparatus according to Claim 23, comprising additionally a steel breaker for breaking the sheet of material passing thereto.

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FIG. A i FIG. A ii FIG. A iii FIG

FIG. B i FIG. B ii FIG. B iii

938381 COMPLETE SPECIFICATION

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Sheet 1

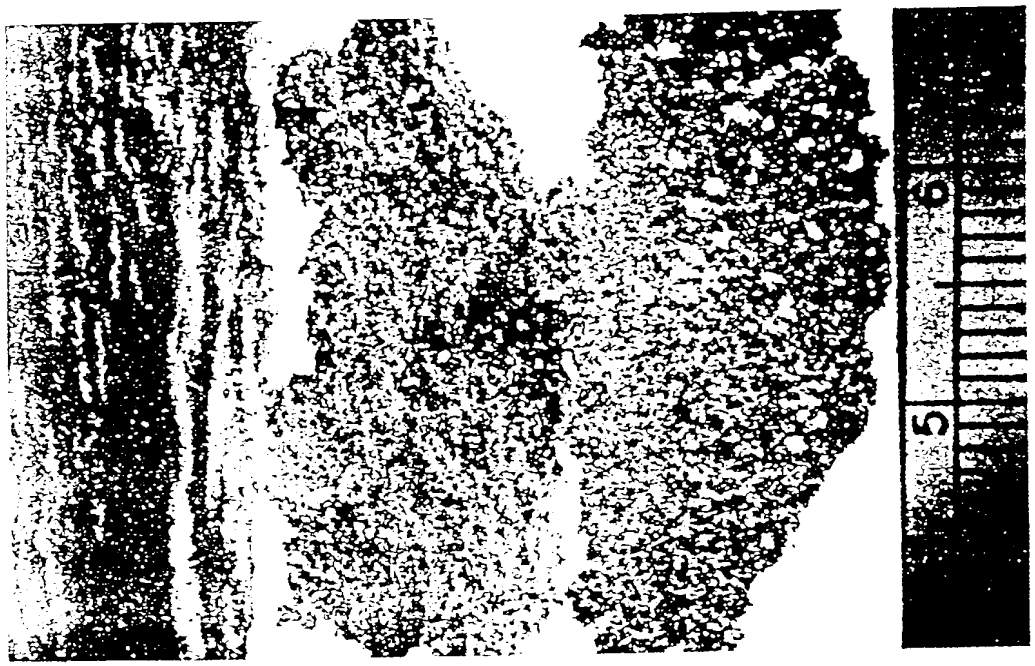

FIG.C i FIG.C ii FIG.C iii

FIG.D i FIG.D ii FIG.D iii

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FIG. A i FIG. A ii FIG. A iii

FIG. C i FIG. C ii FIG. C iii

FIG. B i FIG. B ii FIG. B iii

FIG. D i FIG. D ii FIG. D iii

FIG. 1

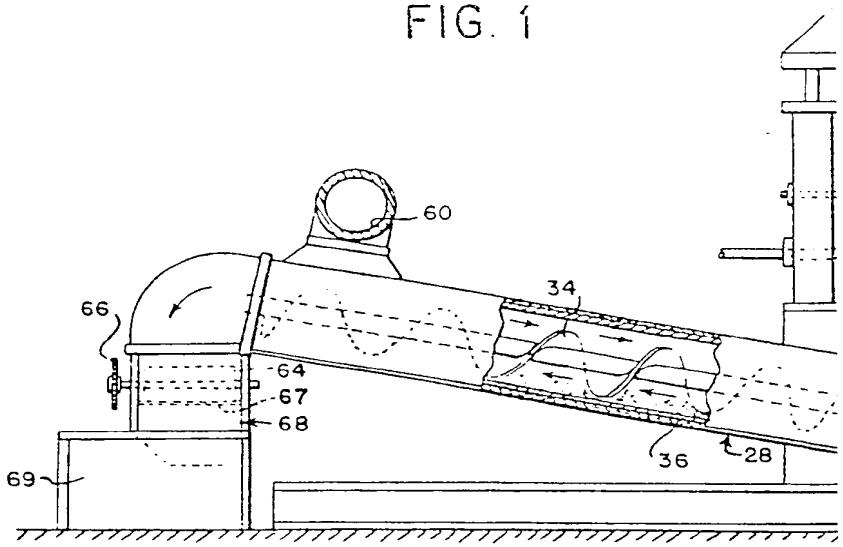
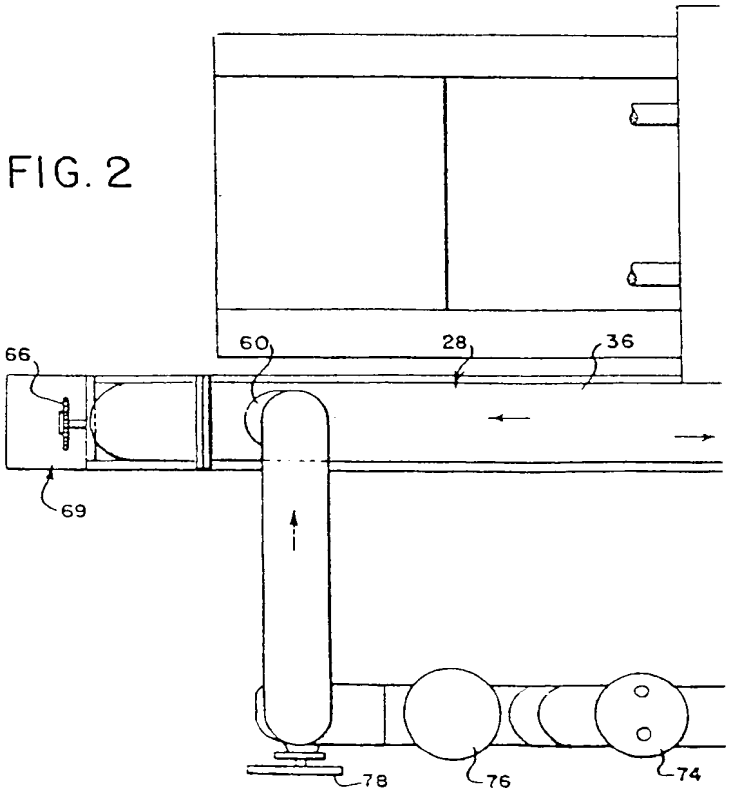


FIG. 2



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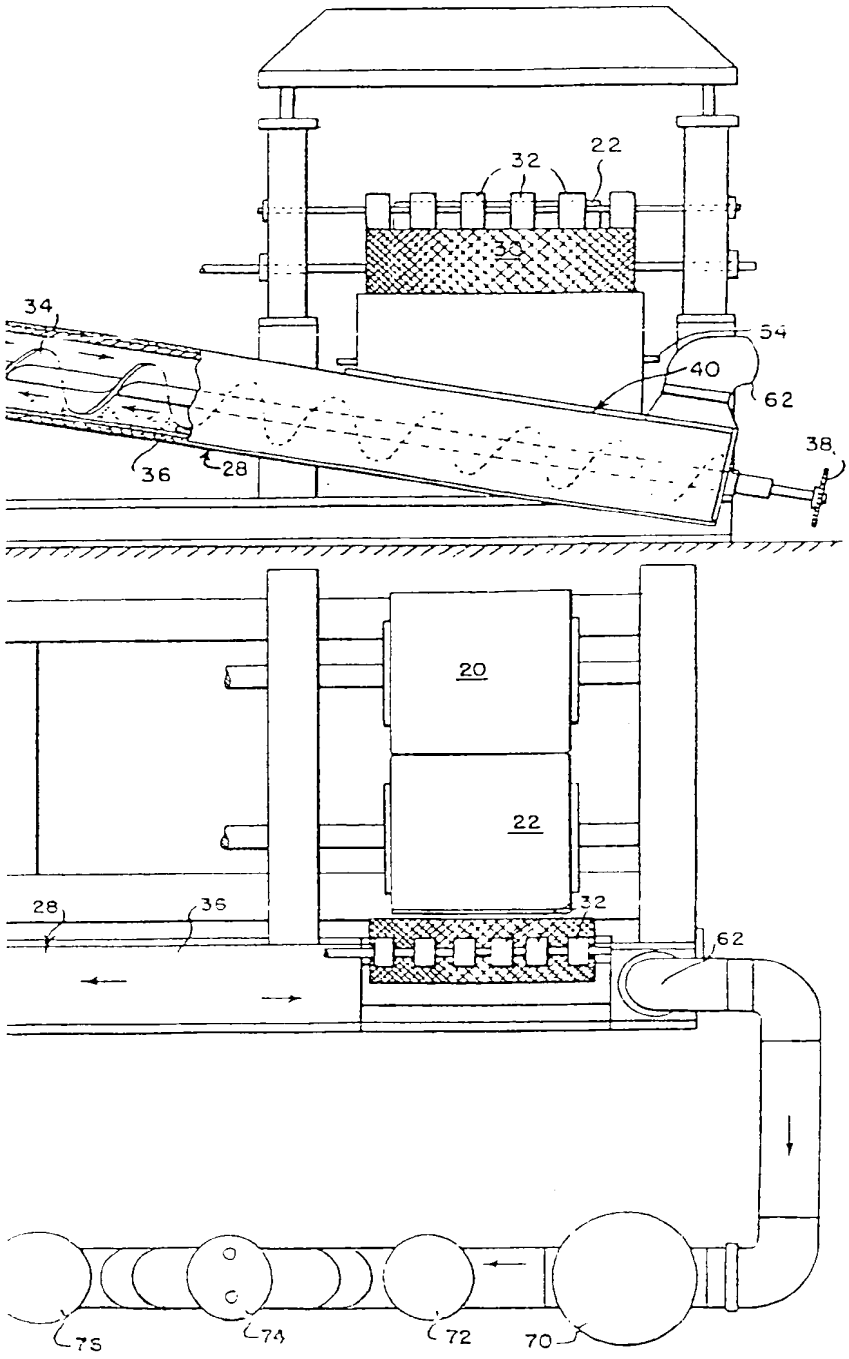

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FIG. 1

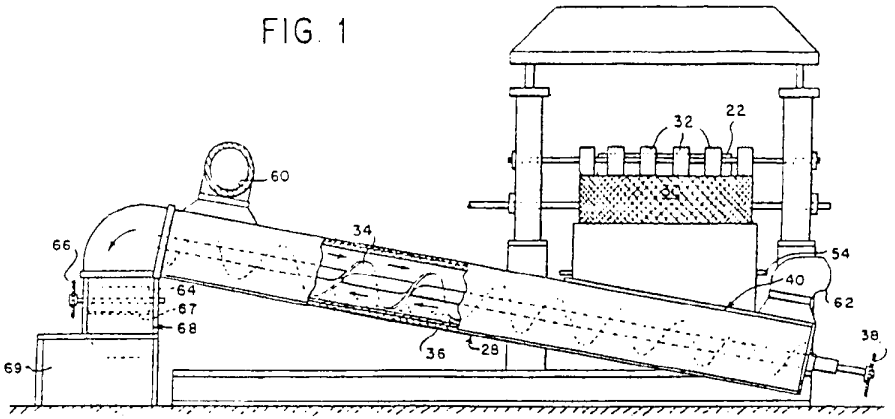

FIG. 2

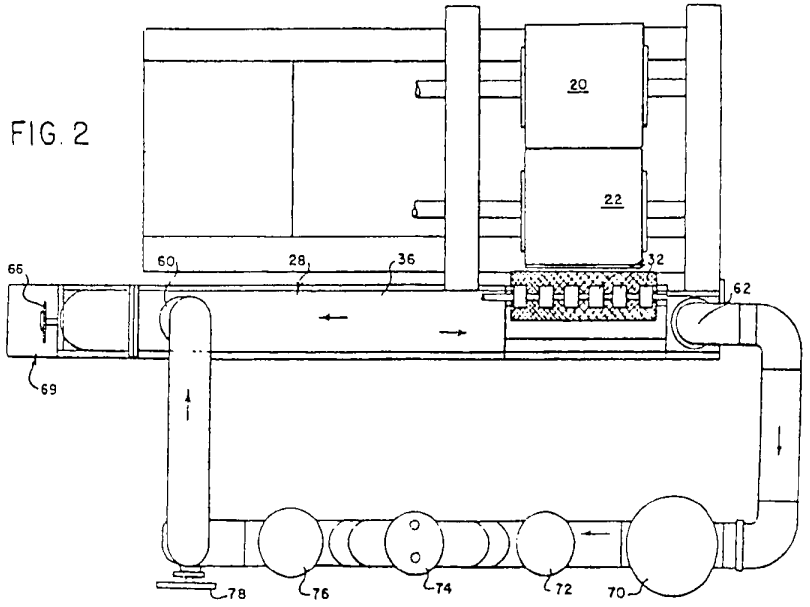

FIG. 3

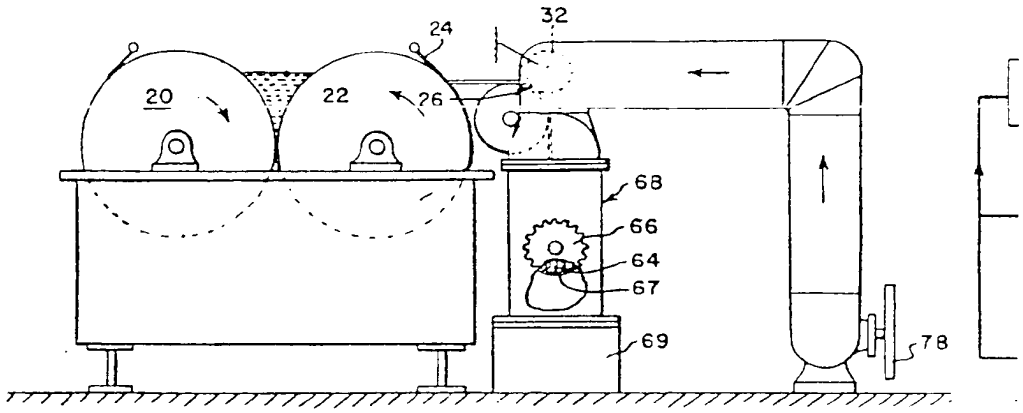

FIG. 5

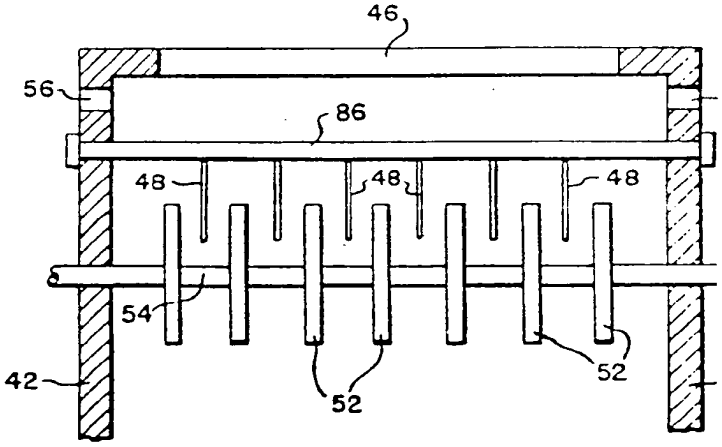

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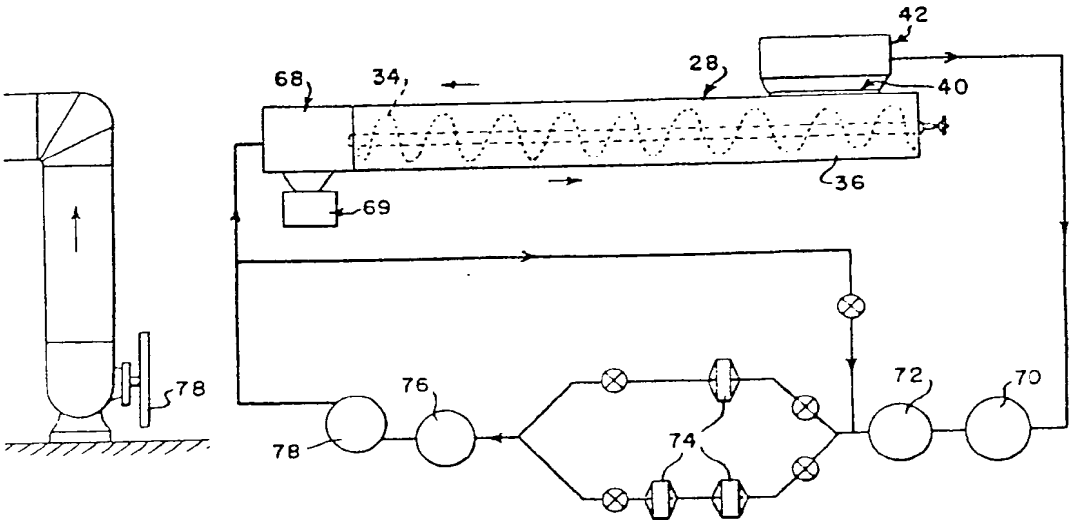
FIG. 4



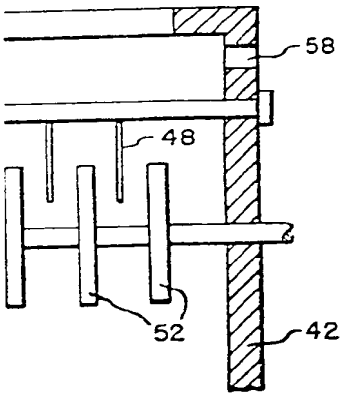


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FIG. 3

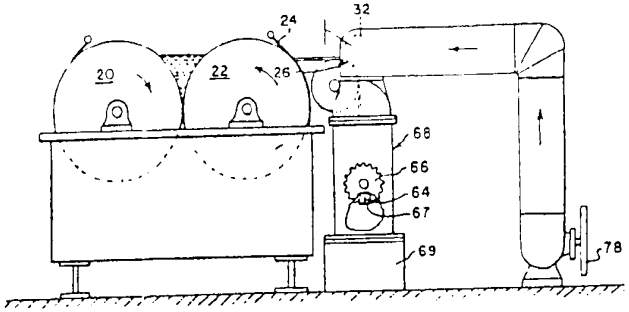

FIG. 4

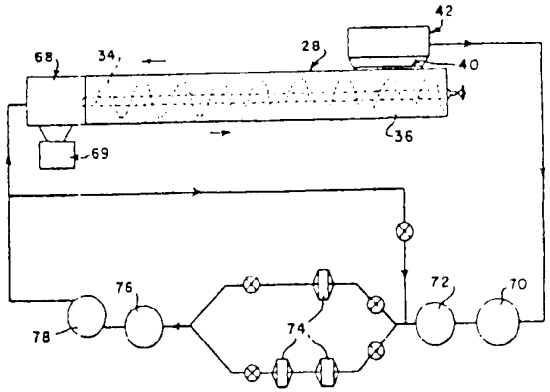

FIG. 5